Discussion on "High β Spokes/Pulsed Operation" by Ken Shepard

This session was a pure discussion session. It focused on Lorentz Force Effects (Lorentz Force Coefficient (LFC), Lorentz Force Detuning (LFD)). Shepard provided the information that for the ANL/RIA spokes the coefficient even for an unconstrained cavity was only a few Hz/(MV/m)^2. Thus they never considered this a problem for their operation. But the results show that spokes are suitable candidates for 4K pulsed operation. Delayen clarified, that the static LFC is not the point of the story. For pulsed operation it needs to be understood, what mechanical modes exist at the harmonics of the pulse frequency. The correlation between the static LFC and the related issues for pulsed operation are not understood at all.
It is difficult to measure LF effects in a vertical test, as the cavity bandwidth is important. Only a loaded resonator has a bandwidth that allows to measure the high frequencies (at least a few kHz) that are dangerous in operation. Instead of beam loading, loading by a 2nd coupler could be used. Success is still not clear as the coupling might not be strong enough (Q_x 10^4 - 10^5) to get to substantial field levels in the rise times needed (a few 100 µsec to 1 msec).
When discussing potential experiments, it turned out that ANL could do pulsed tests on existing hardware with a 1 msec rise time (they have 7 kW of power and need to store around 80 mJ of energy) up to field levels of about 3-4 MV/m. This could give some information on mechanical modes that could be excited.
Pagani contributed details on the excitations that need to be considered. He thinks that experiments by ANL, where they do an amplitude modulation with high frequency is useful, but not sufficient. What is needed, is an excitation with cavity deformations that resemble the LFD effect. He reported numerical experiments, where they did determine the 3D deformations due to Lorentz Forces and excited 3D models of cavities with sinusoidal variations of these deformations. A frequency sweep will show the electromagnetic oscillations (using Slater's Theorem) and the excitation of mechanical modes (with a mechanical modeler). He also mentioned that the pulse shape (giving the relative contributions from different frequencies) is of less importance, than the repetition pattern of the pulse.
He further elaborated on the numerical complexity of the task. Low frequency mechanical modes (a few 10s or 100s of Hz) are excited through harmonics of deformations at several kHz. The electromagnetic effects are driven by marginal structure deformations in the nm-range.
Shepard summarized the issue as: "We need to characterize the transfer function of the cavity-auxiliary system to as high a frequency as possible". Pagani mentioned that Kako from KEK has done very useful work on this topic. Delayen emphasized the importance of the characterization of the "real" system including external forces, auxiliary components, ...
Pagani re-iterated that the transfer function cannot be obtained by a white noise excitation of the cavity system, as the deformations are not the LFD triggered deformations.
In summary, spoke resonators are promising candidates for pulsed operation with little LFD issues. Useful measurements should be developed in a coordinated effort.